Automation of a Hydrodynamic Model of the Tidal Delaware River for Rapid Assessment of Spill Impacts on Water Intakes

7th National Monitoring Conference
April 28, 2010
Denver, Colorado

Delaware River Basin Commission
DELAWARE · NEW JERSEY
PENNSYLVANIA · NEW YORK
UNITED STATES OF AMERICA

John Yagecic, P.E.
Robert Limbeck
Namsoo Suk, Ph.D.
Delaware River Basin Commission

Delaware River Basin Commission
DELAWARE · NEW JERSEY
PENNSYLVANIA · NEW YORK
UNITED STATES OF AMERICA

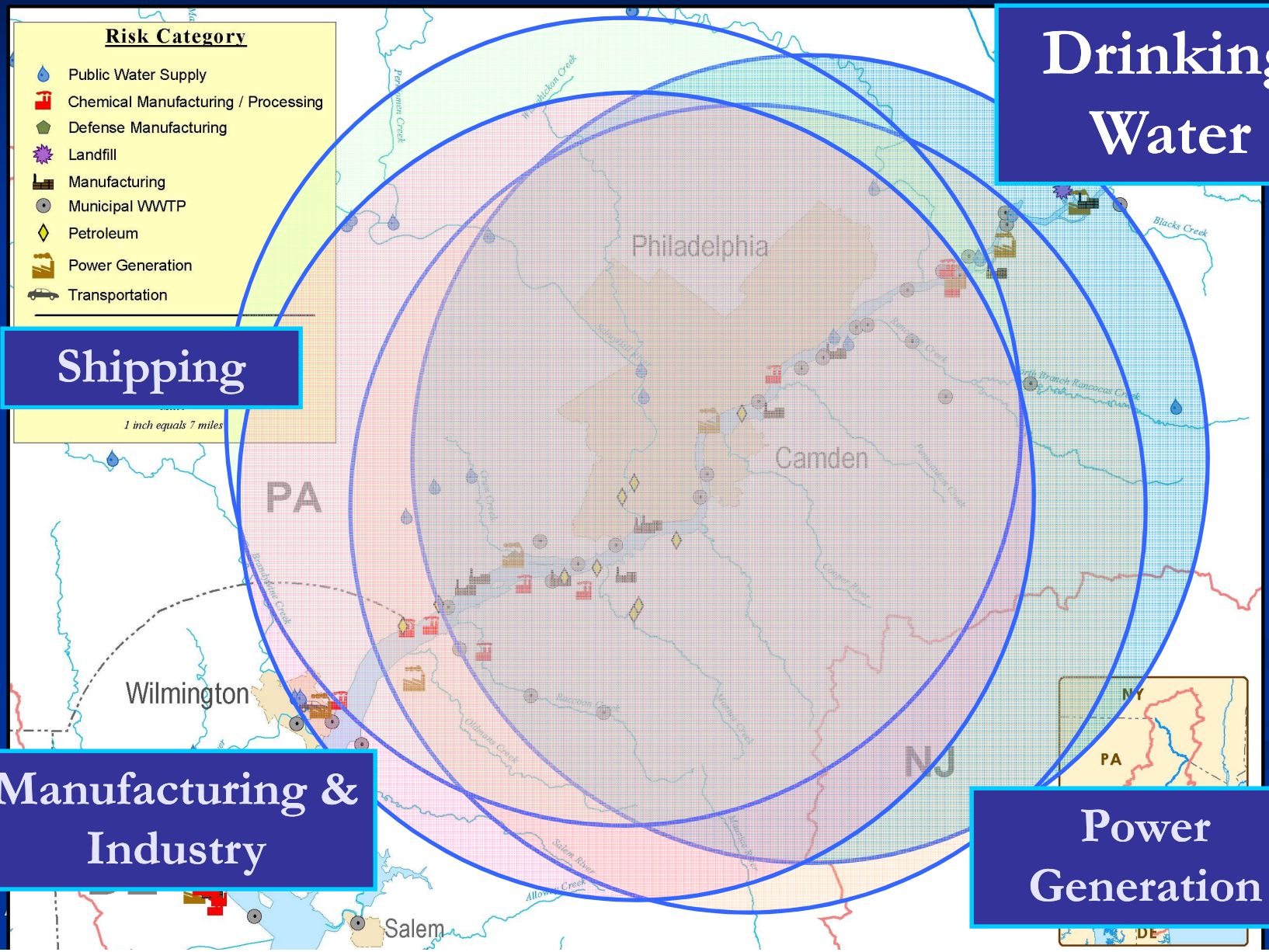
Delaware River Basin Commission
DELAWARE · NEW JERSEY
PENNSYLVANIA · NEW YORK
UNITED STATES OF AMERICA

A Hard Working River…

- Drinking Water for over one million people;
- 3rd largest petrochemical port - 42 million gallons of crude each day;
- Largest North American port for steel, paper, and meat;
- Largest importer of cocoa beans and fruit on the east coast;
- Worlds largest freshwater port;
- 6 nuclear reactors;
- $19 billion annually;
- Strategic military port;
- Delaware River refinery complex provides 70% of gasoline and heating oil for entire East Coast.

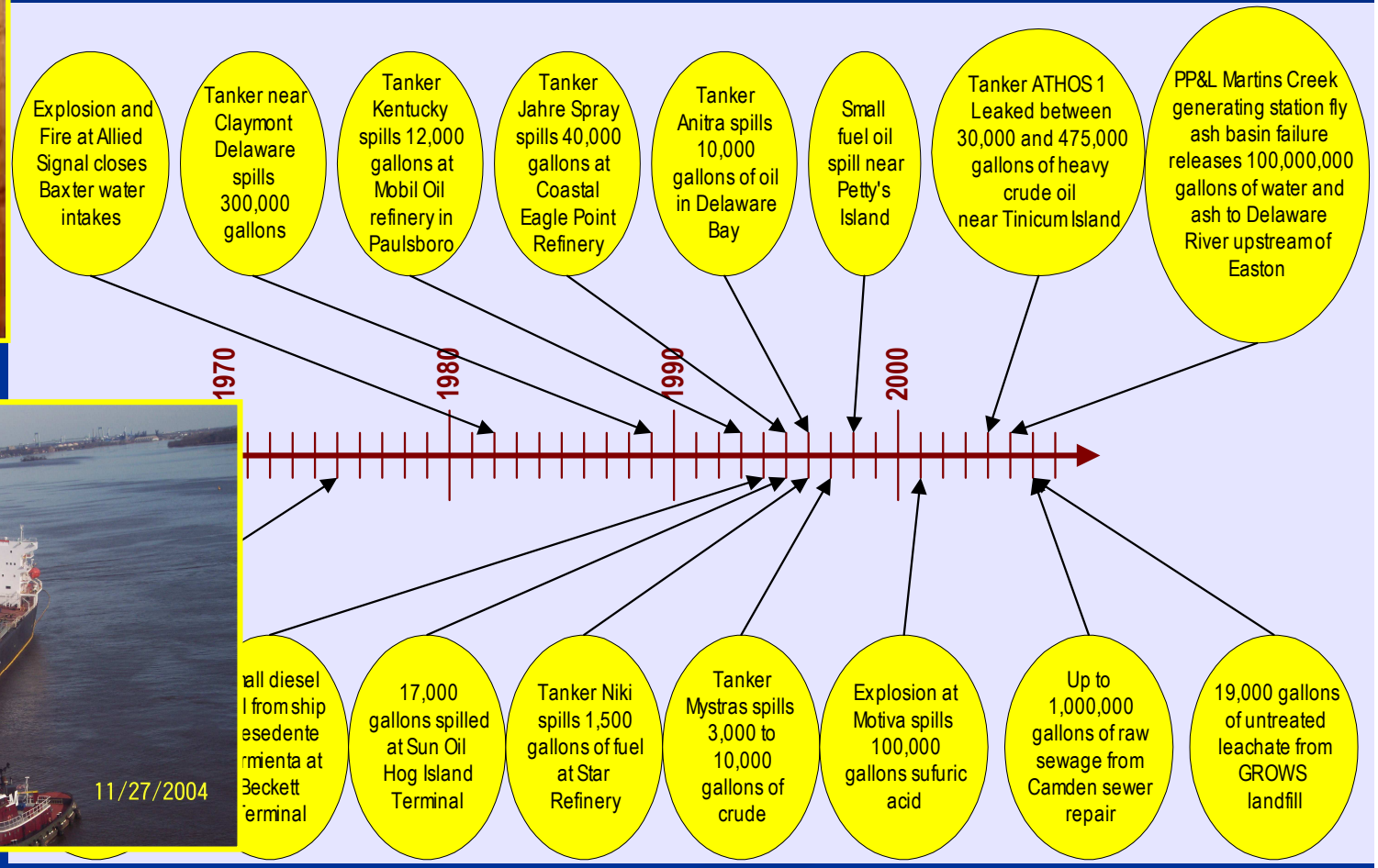
Overlapping Needs…

Delaware River Basin Commission
DELAWARE · NEW JERSEY
PENNSYLVANIA · NEW YORK
UNITED STATES OF AMERICA



Delaware River Basin Commission
DELAWARE · NEW JERSEY
PENNSYLVANIA · NEW YORK
UNITED STATES OF AMERICA

And Spills Do Happen…



Photos of Athos 1 courtesy U.S. Coast Guard

Delaware River Basin Commission

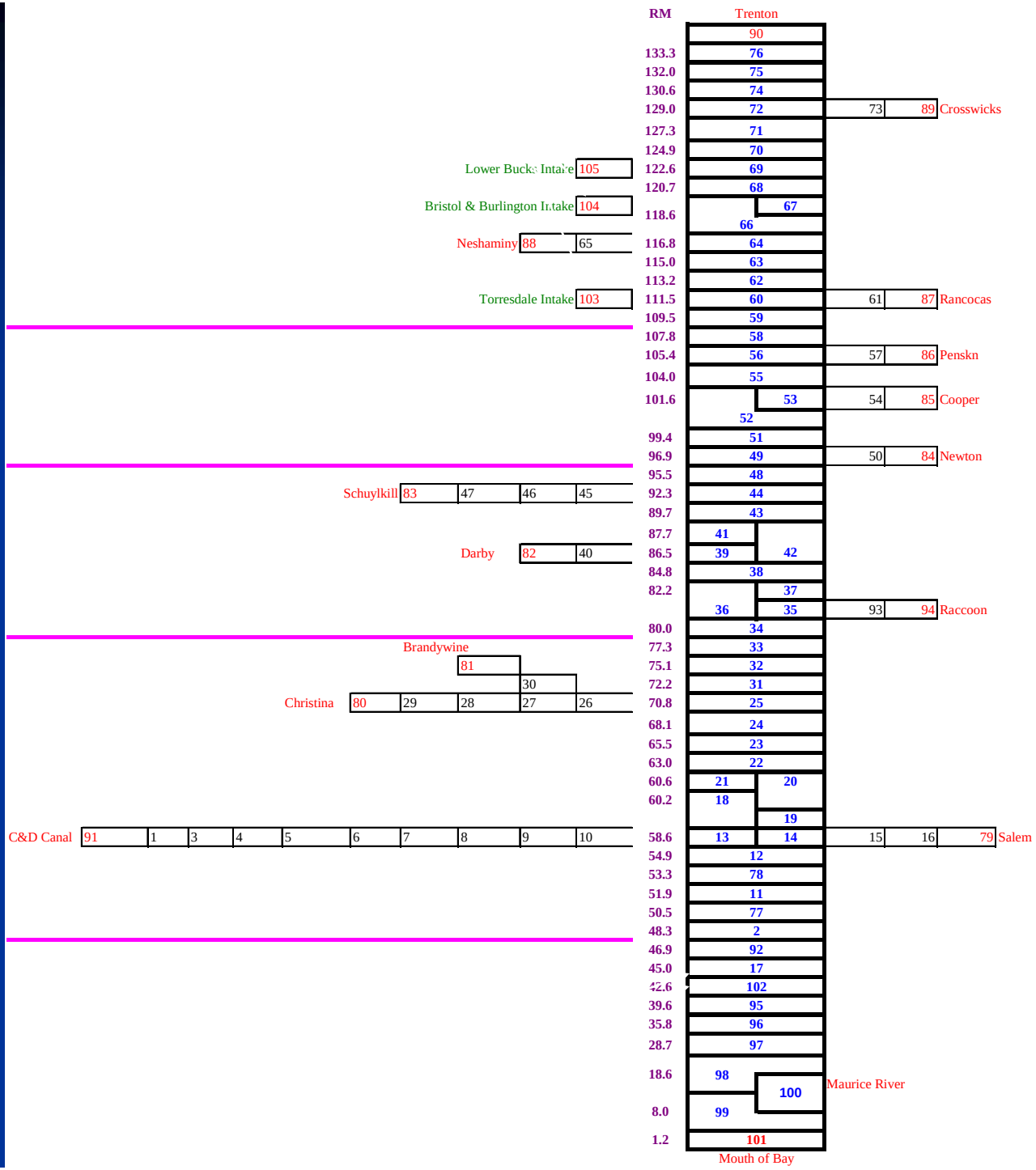
DELAWARE · NEW JERSEY
PENNSYLVANIA · NEW YORK
UNITED STATES OF AMERICA

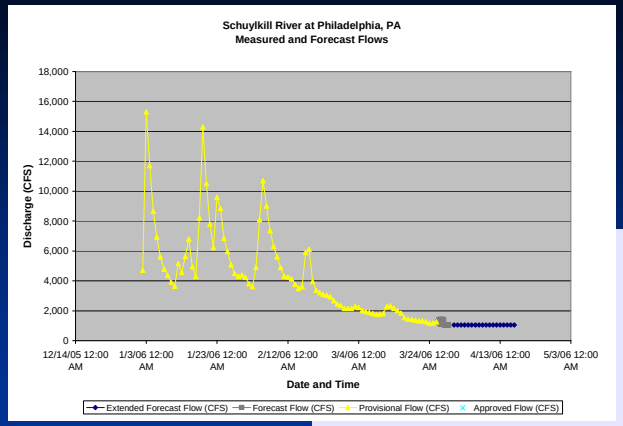
1-D tidal hydrodynamic model using DYNHYD developed by Dr. Namsoo Suk as part of the Stage 1 PCB TMDL

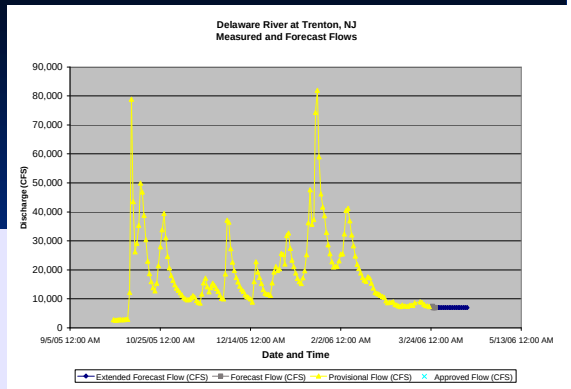
Delaware River Basin Commission.2003a.DYNHYD5 Hydrodynamic Model (Version 2.0)and Chloride Water Quality Model for the Delaware Estuary. Delaware River Basin Commission. West Trenton,NJ. September 2003.

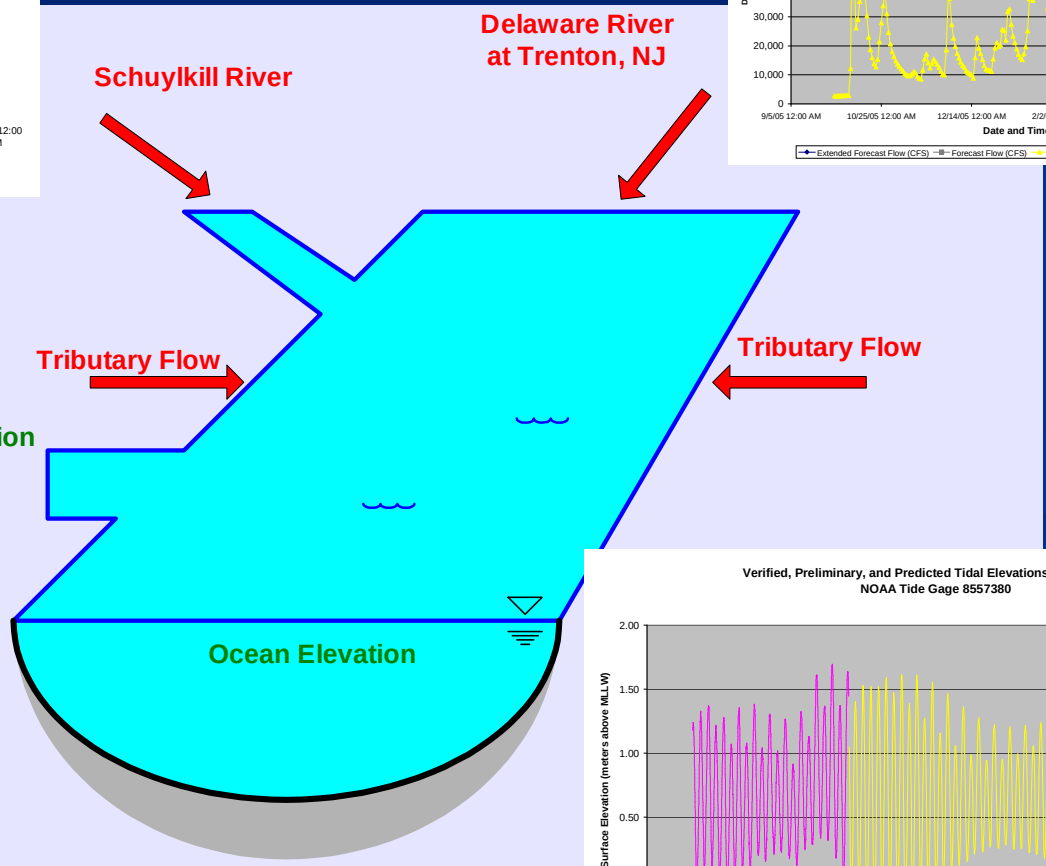
http://www.epa.gov/reg3wapd/tmdl/pa_tmdl/delaware%20river/Hydrodynamic_Model_Report.pdf

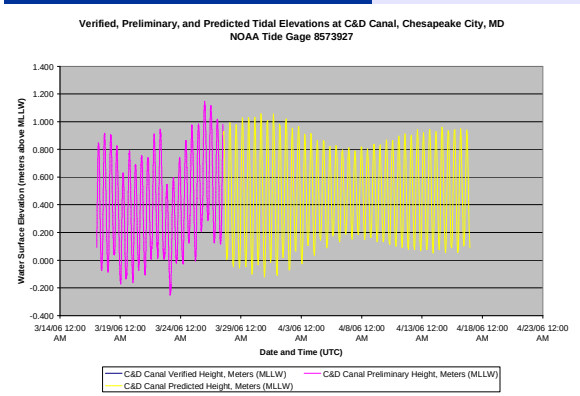
April 2010

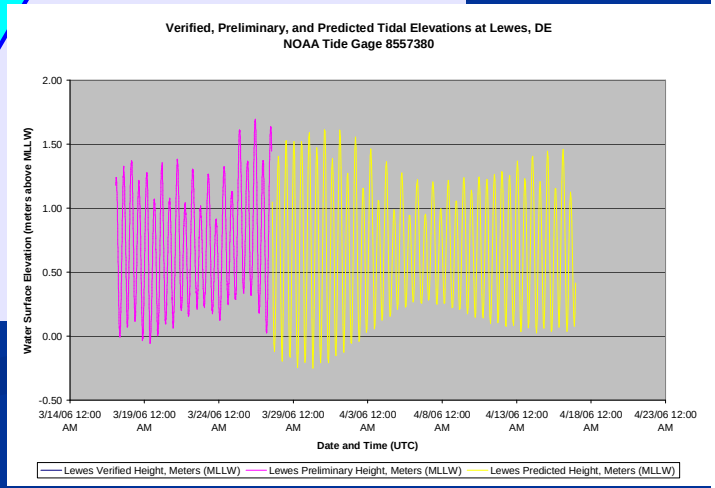



Schuylkill River at Philadelphia, PA
Measured and Forecast Flows
Discharge (CFS)
Date and Time
Extended Forecast Flow (CFS)
Forecast Flow (CFS)
Provisional Flow (CFS)
Approved Flow (CFS)


Delaware River at Trenton, NJ
Measured and Forecast Flows
Discharge (CFS)
Date and Time
Extended Forecast Flow (CFS)
Forecast Flow (CFS)
Provisional Flow (CFS)
Approved Flow (CFS)


Schuylkill River
Delaware River at Trenton, NJ
Tributary Flow
Tributary Flow
C&D Canal Elevation
Ocean Elevation

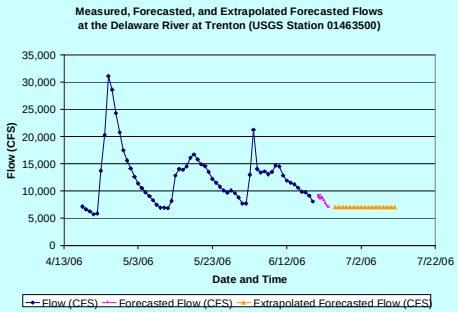

Verified, Preliminary, and Predicted Tidal Elevations at C&D Canal, Chesapeake City, MD
NOAA Tide Gage 8573927
Water Surface Elevation (meters above MLLW)
Date and Time (UTC)
C&D Canal Verified Height, Meters (MLLW)
C&D Canal Preliminary Height, Meters (MLLW)
C&D Canal Predicted Height, Meters (MLLW)

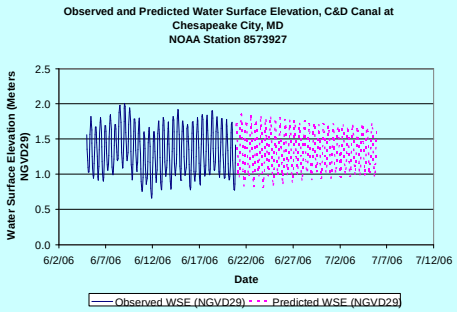

Verified, Preliminary, and Predicted Tidal Elevations at Lewes, DE
NOAA Tide Gage 8557380
Water Surface Elevation (meters above MLLW)
Date and Time (UTC)
Lewes Verified Height, Meters (MLLW)
Lewes Preliminary Height, Meters (MLLW)
Lewes Predicted Height, Meters (MLLW)

Conceptual Schematic of Automated Hydro Model

Delaware River Basin Commission
DELAWARE · NEW JERSEY
PENNSYLVANIA · NEW YORK
UNITED STATES OF AMERICA

Automated Daily Processes No User Input Required





Freshwater Boundary Discharge Data and Predictions

Tidal Boundary Water Surface Data and Predictions

Pre-Processor develops model input file → **DYNHYD5** →

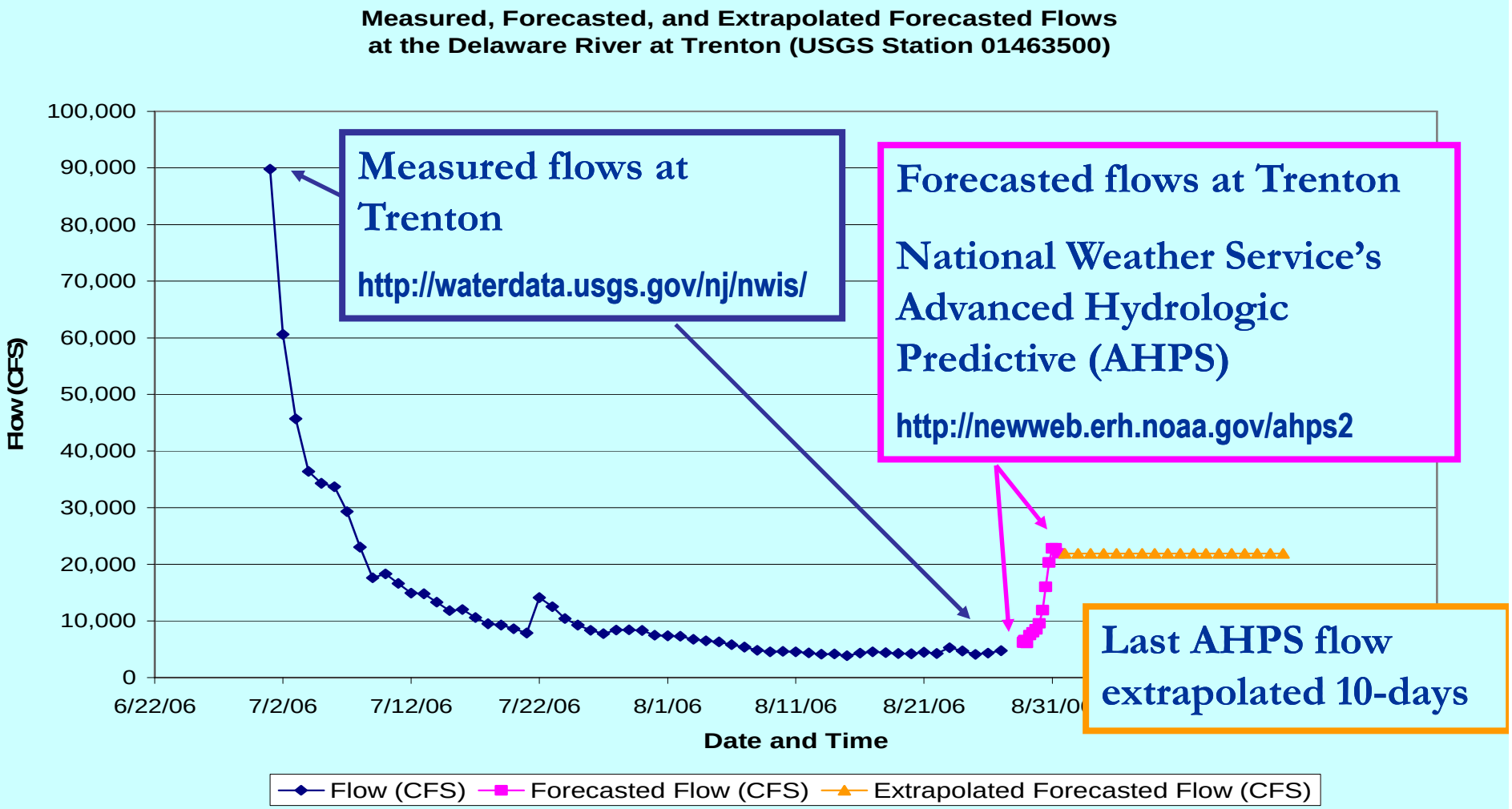
Water Quality Simulation in Response to Spill Event

Spill Data → **WASP** →

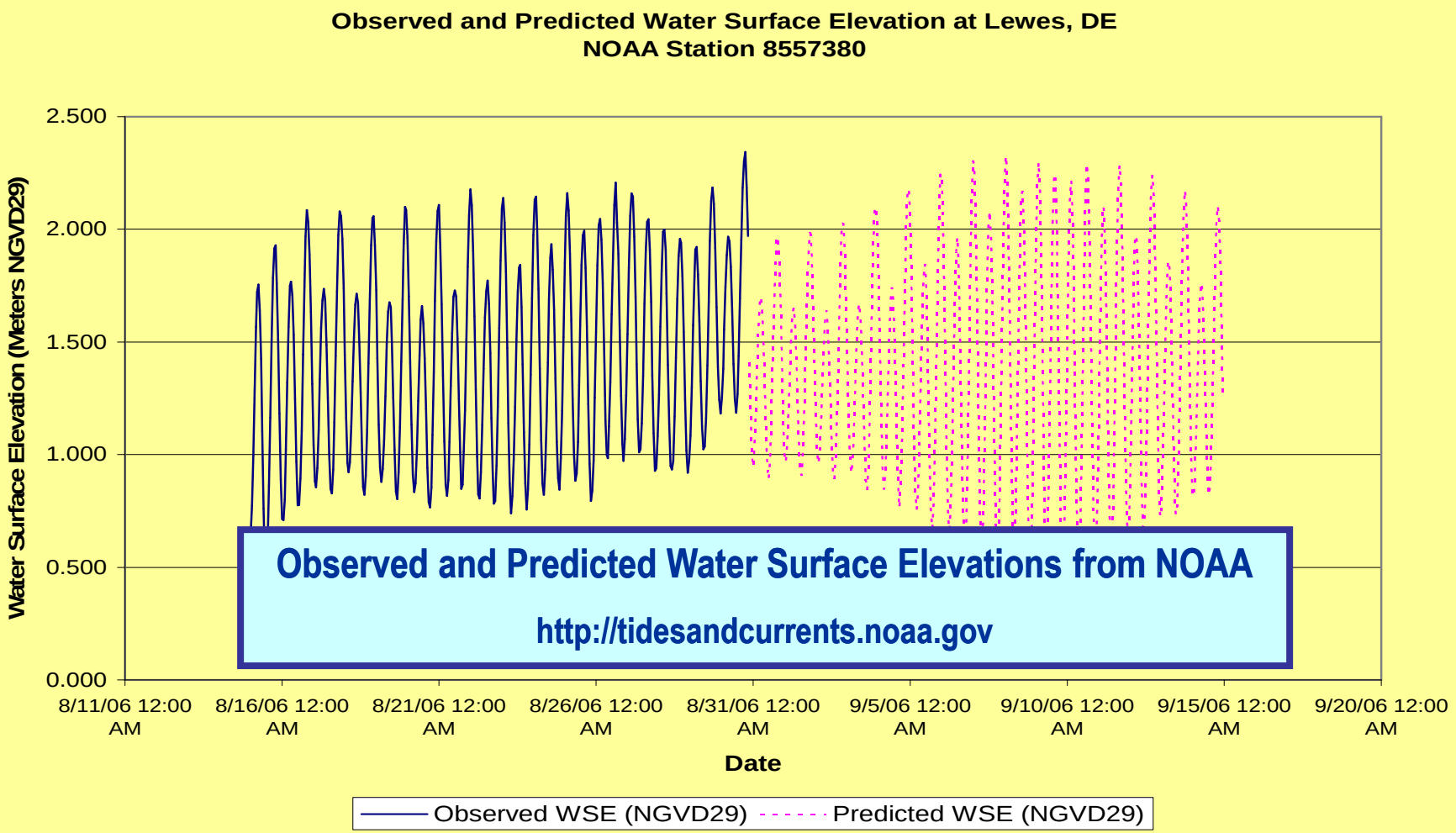
Predicted Location, Duration, and Concentration of Impacted Water Intakes

Prescriptive Measures to Mitigate Impact

Example Non-Tidal Boundary Flow Time Series



Example Tidal Boundary WSE Time Series



Observed and Predicted Water Surface Elevations from NOAA

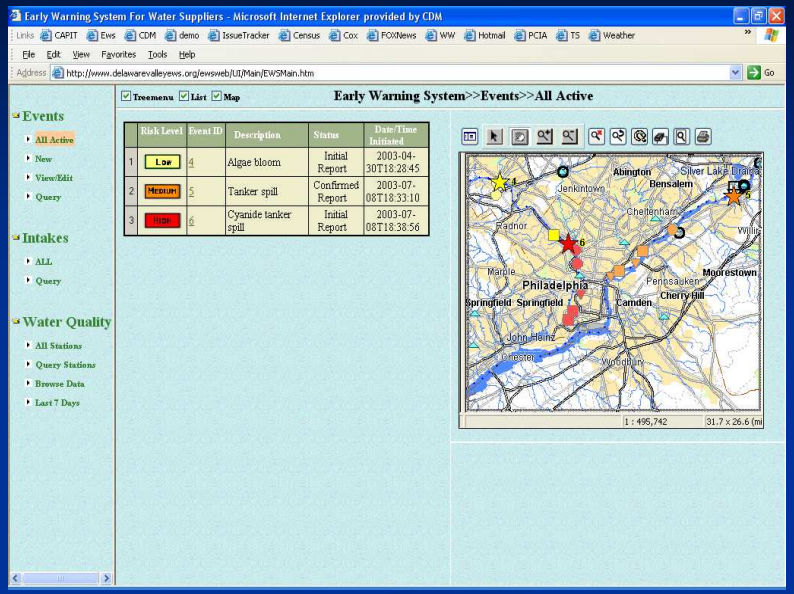
http://tidesandcurrents.noaa.gov

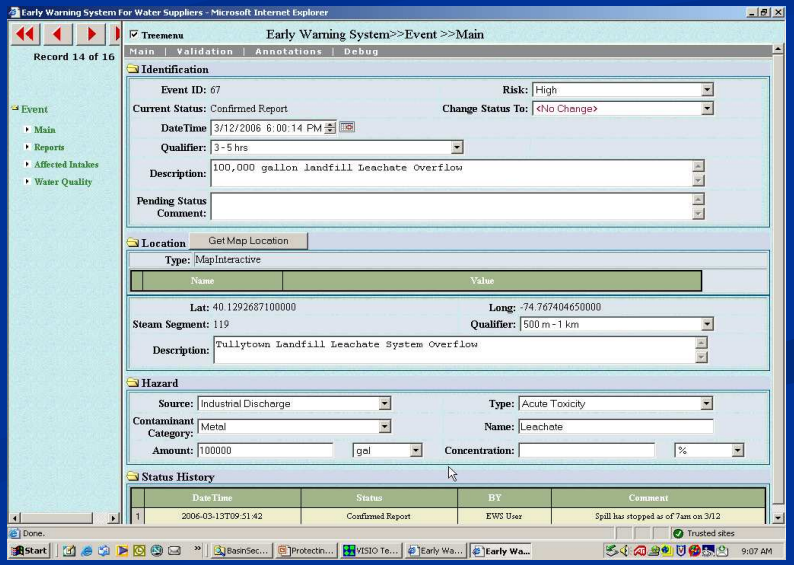
Very Brief Case Study – Leachate Spill

- At about noon on March 13, 2006, we received notice from the Early Warning System that 100,000 gallons of untreated leachate had spilled from a landfill in Tulleytown, PA;
- The estuary flow model had run the night before, predicting flow patterns for the next several days;
- DRBC entered volume, location, and time of discharge into the water quality model to track likely movement and concentration of pollutant.

Early Warning System

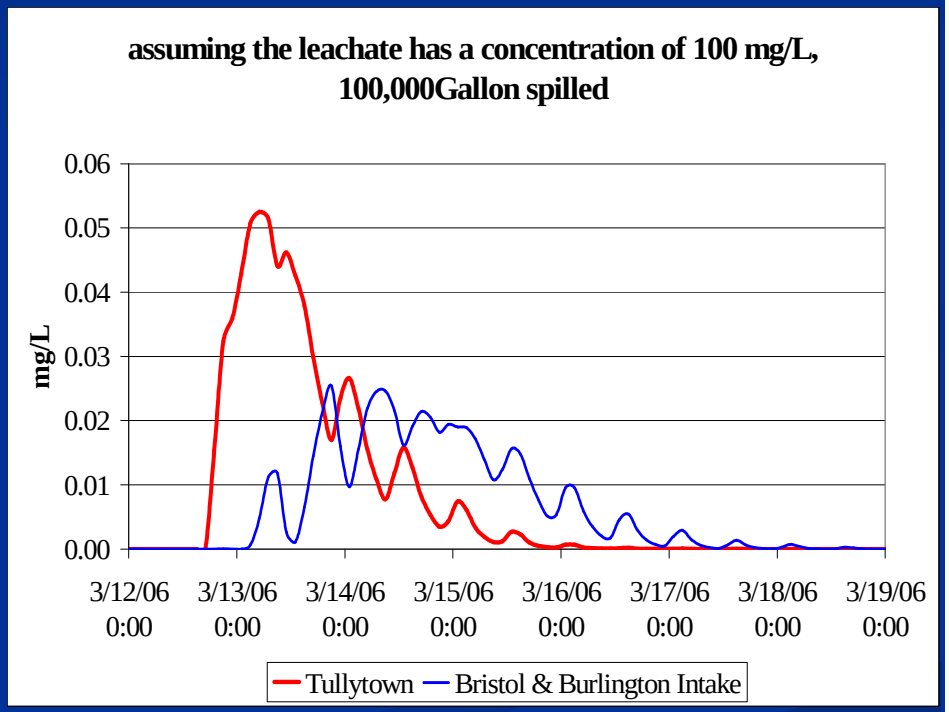
- Philadelphia Water Department developed and maintains the system
- Web Based clearinghouse for notifications of spill and water quality events
- Telephone and e-mail notifications
- Water Purveyors (currently)
- Secure web system





Results of Water Quality Model

- By 5 PM that same day, had contacted 3 water intakes;
- Were able to tell them approximately when the pollutant would be at its highest concentration and when it would abate.



Comments and Observations

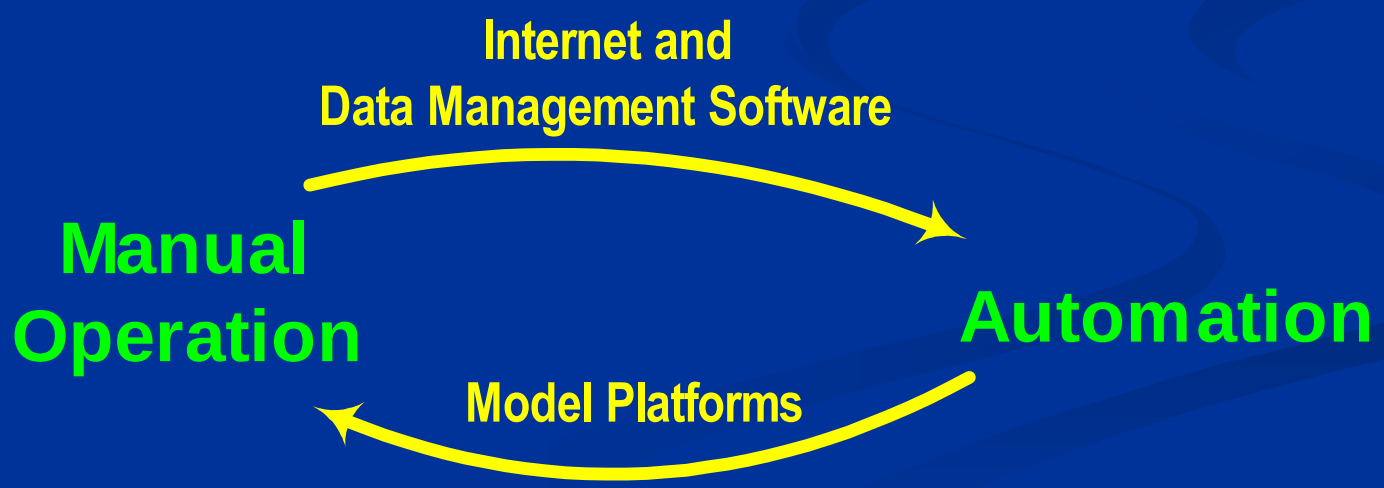
- Developed using standard business software (Excel VBA);
- Automated execution using standard Windows accessories (Task Scheduler);
- Also developed automated software to obtain confirmation data and develop goodness-of-fit metrics;
- Built in checks to demonstrate that the system ran overnight;
- Has executed very consistently since April 2006;
- Easily portable to other systems (where comparable gage and flow forecast data exists).

Goals for Continued Development (in order)

1. Working with Philadelphia Water Department to incorporate model into Delaware Valley Early Warning System (EWS);
2. Develop a parallel track multi-dimensional model (looking for collaborators);
3. Couple with an oil plume model.

Model Automation Paradox

- Continued development of the internet and data software make automated model input feasible;
- Simultaneously, however, model platforms are migrating away from command line execution, into the Windows environment, requiring more (not less) user interaction to execute;
- Developers need to consider a "back door" to allow for automated applications.



Questions?

Automation of a Hydrodynamic Model of the Tidal Delaware River for Rapid Assessment of Spill Impacts on Water Intakes

7th National Monitoring Conference
April 28, 2010
Denver, Colorado
CONTACT: John.Yagecic@drbc.state.nj.us

Delaware River Basin Commission
DELAWARE · NEW JERSEY
PENNSYLVANIA · NEW YORK
UNITED STATES OF AMERICA

- John Yagecic, P.E.
- Robert Limbeck
- Namsoo Suk, Ph.D.
- Delaware River Basin Commission